Ref #7

347
Spruce budworm
RESEARCH

UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH ADMINISTRATION
BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE

Project | Date May 7, 1951 | Author Robert E. Denton

SUBJECT—

TITLE

INVESTIGATIONS OF THE SPRUCE BUDWORM AND ITS CONTROL: SOME APPLICATIONS OF THE RESULTS OF FORCED EMERGENCE OF HIBERNACULA

PROGRESS REPORT, SEASON OF 1950

Forest Insect Laboratory
Coeur d'Alene, Idaho
May 7, 1951

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6-11-51

Bob:

Val and I kicked Denton's report around somewhat and formulated some ideas to discuss with Denton when he visited the Union Laboratory. Denton was at Union the past weekend and I presume he and Conlin went over various aspects of the report.

It is encouraging to see someone at the Cornell Ithaca Laboratory working on the bedbug problem — there is plenty of work to go around.

Conlin and I feel that the study was well-conducted, although on a rather small scale to obtain any concrete results. Using small traps as Denton did, we are sure he must have been coping both too smooth to harbor many larvae. When considering the many factors that may influence the population surviving the hibernation period, I personally feel that the use to which we undertake hibernating larvae rearing — to determine status of the overwintering population — is about all that can be safely attempted as yet. Until the many complexities of the problem are ironed out I don't if we would look publish the extent of damage the coming season on the basis of overwintering larvae rearing counts.

(over)

I have not had time to really sit down and think this site visit over thoroughly. I hope to do so this fall and begin on exchange of correspondence on these investigations with Peter.

Thanks for sending the report to me for comment.

Ken

J. C. Evenden, In Charge, Coeur d'Alene May 25, 1951

R. L. Furniss, Entomologist, Portland Laboratory

Report - Investigations of the Spruce Budworm and Its Control: Some Applications of the Results of Forced Emergence of Hibernacula, Progress Report, Season of 1950 by R. E. Denton

Mr. Denton's report is of particular interest to us because of similar studies in progress in this region. We too have been trying to correlate the overwintering budworm population, as measured by forced rearings of hibernating larvae, with subsequent defoliation.

Experience in the Northeastern States has shown that the character of the rearing cages and the conditions maintained in them have a marked bearing upon the number of budworm larvae that enter the collecting tubes. Preliminary studies conducted in Oregon have given similar results. Carolin and Wright are making further studies to determine the best type of cage for the forced rearing of overwintering budworm larvae. Also, I might add that the great bulk of our rearings have been from limbs rather than from the bole of the sampled trees.

Mr. Denton's report is being referred to Carolin and Wright for possible comments.

cc: Dr. Beal
New Haven
Berkeley
Ft. Collins
Ogden

RLFurniss:AH

Copy Sent: K. H. Wright

RLPurnias:AH

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Reply by RLF
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Entomology and Plant Quarantine
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☆ MAY 23 1951 ☆
FOREST INSECT LABORATORY,
PORTLAND, OREGON

Forest Insect Laboratory
Coeur d'Alene, Idaho

May 18, 1951

To: J. A. Beal, In Charge, Forest Insect Investigations

From: James C. Evenden, P. O. Box 630, Coeur d'Alene, Idaho

Subject: Spruce Budworm Studies

I am enclosing a copy of a report by Mr. Denton, showing the application of the results of forced emergence of spruce budworm hibernacula. Although this report admittedly does not tell a significant story, it does portray the potentials of using such data to predict subsequent budworm populations.

Our experience with this insect indicates the difficulty of using one years defoliation to predict the subsequent years budworm population. We have found that severe damage can drop to an almost negligible feeding, only to rebuild to a former destructive level. In fact my prediction as to spruce budworm behavior has been very much on the wrong side. We feel the need of an index to the subsequent population, that is much closer than the preceding season's defoliation. If the correlation between the forced emergence of overwintering hibernacula and the subsequent budworm population is found to be fairly significant, the task of planning budworm control would become more simple than at this time.

Comments of Mr. Denton's report will be appreciated.

cc: Portland ✓
Berkeley
Fort Collins
Ogden
Eastern Laboratories

INVESTIGATIONS OF THE SPRUCE BUDWORM AND ITS CONTROL: SOME APPLICATIONS OF THE RESULTS OF FORCED EMERGENCE OF HIBERNACULA

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INVESTIGATIONS OF THE SPRUCE BUDWORM AND ITS CONTROL: SOME APPLICATIONS OF THE RESULTS OF FORCED EMERGENCE OF HIBERNACULA

by
Robert E. Denton, Entomologist

HISTORY AND NECESSITY FOR SPRUCE BUDWORM RESEARCH IN THE NORTHERN ROCKY MOUNTAINS

Since 1922 several potentially serious outbreaks of the spruce budworm Choristoneura fumiferana (Clem.), have been periodically reported from Idaho, Montana, and Wyoming. Until recent years, methods of applying control over large forested areas were non-existant and entomologists of the Coeur d'Alene Forest Insect Laboratory could assume only a watchful-waiting attitude until natural factors halted the outbreaks.

The present day method of control by aerial spraying has been successfully demonstrated in the majority of the regions where it has been tried. However, application of this method in the northern Rocky Mountains is complicated because of several conditions and features peculiar to this area as a whole. Vast acreages, conservatively estimated between 3 and 4 million, contain the favored host species Douglas-fir and true firs, and populations of the spruce budworm varying from endemic to epidemic are known to be present over at least three-fourths of this acreage.

Under these conditions periodic outbreaks may be expected to occur. Yet in recent years several infestations have been recorded in the northern Rocky Mountains that, although epidemic in numbers of budworms, subsided within a few seasons due to natural factors, with no economic damage to the timber.

Two highly opposing situations are presented. On the one hand, factors such as the high total cost of aerial control, plus hazardousness of control operations in rugged terrain and low timber values in many localities all tend to make artificial control difficult over much of the northern Rockies. On the other hand, Douglas-fir is the foremost species in volume of timber cut on commercially operated forest lands, and likewise it is the primary species of the vast Christmas tree industry of Montana. Thus it is apparent that some form of compromise must govern the outlook toward artificial control, but in any instance, the necessity for applying such control must be thoroughly examined.

The ultimate problem, then, is the determination of that degree of intensity of an infestation, measured in terms of economic damage, when control is warranted.

Answers to the many problems posed by the spruce budworm can be gotten only by intensive, long term research concerning its habits, factors contributing to its control, and the causes of the fluctuations in infestations (1).

SCOPE AND OBJECTIVES OF THE PRESENT STUDY

The spruce budworm has been of major concern in the Douglas-fir forests of the Helena National Forest, Montana for several years, and has been responsible for considerable mortality of forest trees in some localities. An initial survey of the infestation was made by Mr. Philip C. Johnson in 1948 in compliance with a request from the Forest Service through the Beltsville, Maryland office of the Bureau of Entomology and Plant Quarantine concerning possible working areas for an experimental program of spruce budworm control by aerial spraying (2). In 1949 another survey was made to determine more fully the distribution and severity of the infestation, resulting in recommendations for an experimental project in 1950 (3). In general, the purpose was to test the feasibility of controlling infestations of the spruce budworm in Douglas fir forests of the northern Rocky Mountains.

Early in 1950 techniques were outlined to collect samples from budworm infested trees in the Helena National Forest and force the emergence of the hibernacula. Essentially, the outline followed closely the techniques developed by personnel of the Portland, Oregon Forest Insect Laboratory, and will be discussed in more detail elsewhere.

The objective of the spring rearing of budworms was to predetermine the 1950 population densities in the several drainages so that limited spraying operations could be directed to those areas harboring the greater numbers of insects. However, due to unforeseen circumstances the control project did not materialize and computations regarding the spring rearings were discontinued.

In July, conceivable use of the foregoing rearing data led to a renewal of the study from an additional and quite different aspect: To evaluate the results of the spring rearings as possible indices in predicting the damage that will occur in a given area during a current season. Specificially, the purpose was to determine the possibility of correlating the spring-emerging population per unit area of bark surface with subsequent damage to a unit of foliage.

A hypothetical case will illustrate the implications of this objective. A widespread infestation has been in progress for several seasons and there are no indications of a decline in the immediate future. The question of whether or not control should be applied will be answered by sample rearings of budworms in the spring, applied to the knowledge gained from research regarding resultant damage. Thus, it will be

predicted that subsequent damage as indicated by the rearings, will result in mortality beginning with the current season, and control is warranted. Or, that control is not warranted because sample rearings indicate that damage will be slight during the current season.

To date the results of this phase of the study are inconclusive due, at least in part, to the fact that the initial rearing collections were not designed to fulfill the needs of the later study. Even so, the limited data show possibilities that a correlation may be determined by more intensive study.

In effect, this report not only presents the progress of the work during the season of 1950, but it also sets up the continuation of this study for the following seasons.

STATUS OF THE INFESTATION

Outbreaks of the spruce budworm have come and gone in the Helena National Forest for many years. In the drainage Deep Creek, for example, observations by personnel of this laboratory have indicated that in some years entire mountainsides would appear scorched due to budworm feeding; in other years the same mountainsides would be normal, from all appearances.

Since 1943 a rather persistent outbreak has developed, concentrated in the pole-sized, second growth Douglas fir stands in the Big Belt Mountain Range (Fig. 1). The 1949 survey determined a total infestation of 290,000 acres, varying in intensity from light to very heavy. On 10,000 acres, extensive to spotty areas of Douglas fir have been killed. However, a general tapering off of the infestation was noted over the 1948 survey, with the exception of a few drainages. In 1950 the reduction in current damage was considerably less on the whole, although by no means has the infestation subsided.

REARING METHODS

Studies conducted at the Portland Laboratory indicated that in "lighter" infestations a greater proportion of larvae were to be found hibernating on the main stem in comparison to branches and foliage (4).

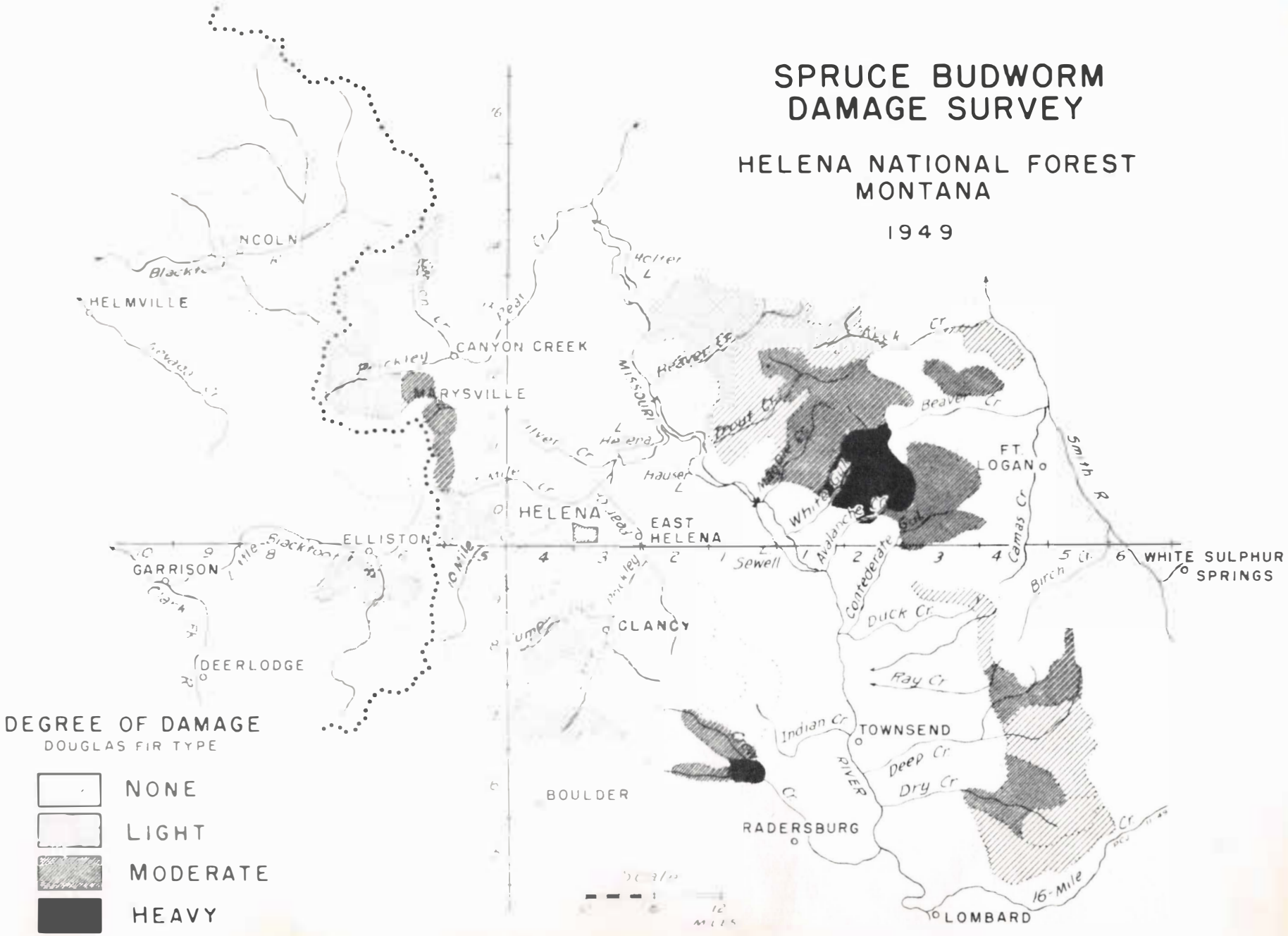
Field collections for this study, therefore, consisted of sections cut from the main stems of Douglas fir trees which averaged 6 or 7-inches, diameter-breast-height. Two samples were obtained at designated collecting locations in each of eight drainages in the Big Belt Mountain Range, in March and again in April.

In general, sampling procedures followed the methods employed by the Portland Laboratory, except that the tree was felled and the entire section was cut out -- instead of stripping a sample of bark from the standing tree.

SPRUCE BUDWORM DAMAGE SURVEY

HELENA NATIONAL FOREST
MONTANA

1949



To check any variation between the regions concerning the location of hibernacula the March samples were taken near the top of the bole in the relatively smooth bark surface area and the April samples were taken somewhat lower on the bole in the roughened bark surface area.

Laboratory rearings were accomplished by placing the bole sections into cardboard boxes fitted with glass vials and recording the number of emerging larvae. The boxes measured 12" x 4" x 5" and were made light-tight with gummed paper, except for a 3/4-inch hole bored through one end. A cork fitted with a glass vial was inserted into this hole, and the strongly photo tropic larvae that emerged were drawn into the vial by means of an external electric light source. Prior to boxing the material the bark surface areas were computed and the sections were quartered so that more surface area could be included in a box after splitting away much of the excess wood.

RESULTS OF REARINGS

Emergence from the bole samples collected in March was very low and erratic in relation to the known conditions in the field. This fact was in all probability due to the smoothness of the bark surface wherein little opportunity was afforded the larvae to find suitable shelter for spinning hibernacula.

Results from the April collections were more significant and, as will be shown later, indicated a possible correlation with subsequent host tree defoliation.

Emergence data compiled from the spring rearings are presented in Table 1. On the basis of the original phase of this study, priority for control would have been given to Marysville, Indian Creek, Magpie Creek, and so forth, in that order, to the extent of the experimental project funds. As will be discussed elsewhere, this order conformed with that of the degree of damage in most instances.

1950 DEFOLIATION IN COLLECTING AREAS

In October each collecting area was re-visited to measure the amount of defoliation, per unit sample of foliage, that had occurred to Douglas fir trees during the current season. At each established location four 15-inch branch terminals were collected from each of 4 trees. The total number of 1950-growth terminals was tabulated, likewise the numbers of 1950 terminals that were partially and completely defoliated. Additional data included the average 1950 needle length, the year of last complete defoliation, and the number of pupal cases for each 15-inch terminal. From the resulting tables the average amount of defoliation per 15-inch sample was computed for each drainage.

TABLE 1. -- EMERGENCE OF HIBERNACULA REARED IN THE LABORATORY FROM BOLE SAMPLES.

Location of Collections	No. Larvae Emerged		No. Larvae Per 100 Sq. Inches Bark Surface	
	March	April	March	April
Marysville	14	89	5.7	29
Indian Creek	3	53	1.6	22
Magpie Creek	0	45	0.0	12
Deep Creek	13	38	6.4	11
Avalanche Gulch	2	7	0.3	3
Duck Creek	3	12	1.5	4
White's Gulch	3	33	1.0	5
Benton Gulch	0	10	0.0	4

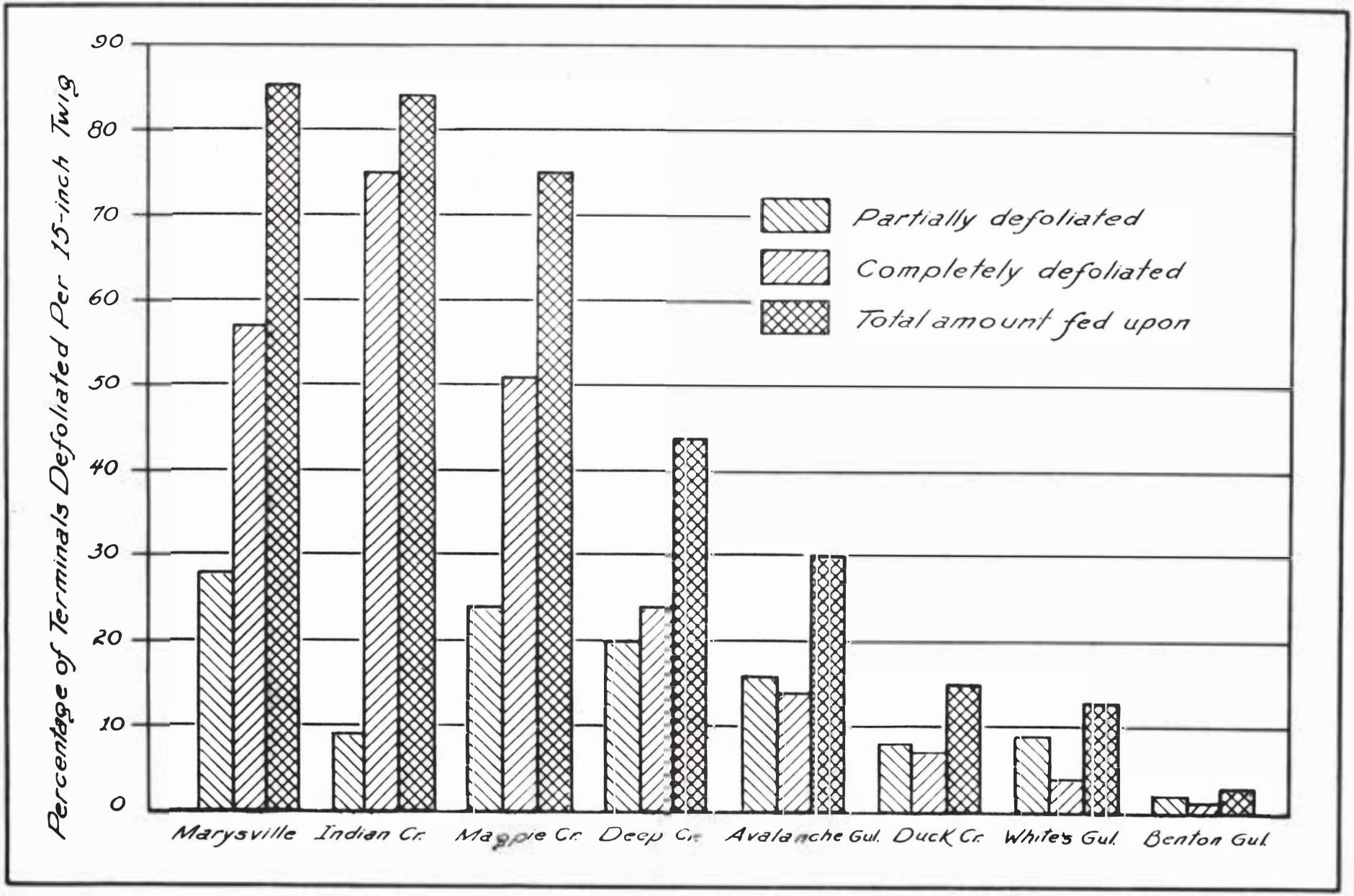


Fig. 2. – Defoliation of 15-inch twig samples.

The amount of damage in each area is presented in Table 2. To facilitate comparison of the damage and the previously measured overwintering population the values have been plotted graphically in Figure 2.

TABLE 2. -- AVERAGE AMOUNT OF DEFOLIATION PER 15-INCH TWIG SAMPLE IN EACH COLLECTING AREA.

(4 twigs × 4 trees)

Location of Collections	Number of 1950-Growth Terminals Per 15-Inch Twig				
	Total	Partially Defoliated	Completely Defoliated	Combined Defoliation	Percent of Total
Marysville	105	29	60	89	85
Indian Creek	44	4	33	37	84
Magpie Creek	64	16	32	48	75
Deep Creek	65	13	16	29	44
Avalanche Gulch	46	7	6	13	30
Duck Creek	38	3	2	5	15
White's Gulch	46	4	2	6	13
Benton Gulch	70	2	1	3	3

RELATION OF SPRING EMERGENCE TO SUBSEQUENT DEFOLIATION

In Figure 3 the two sets of data concerning the rearing emergence and subsequent host tree damage are combined in graphic analysis for purposes of comparison. It should be emphasized that due to the circumstances previously mentioned these data are by no means conclusive. Rather, they are presented here as a suggestion of future possibilities in the study of spruce budworm infestations.

Cursory examination of the graph would indicate that an increasing spring-emerging population between the various collecting areas results in an increase in the corresponding degree of damage. However, such an occurrence would normally be expected, assuming that environmental factors of resistance were of equal importance throughout the area as a whole.

Ideal results would be obtained if a direct ratio were found to exist between the number of emerging larvae per unit area of bark surface and the subsequent degree of defoliation per unit of foliage. However, to date computations have failed to support this possibility.

Plotting the corresponding values for each area on cross-sectional paper produced more promising results (fig. 4). Obviously, much

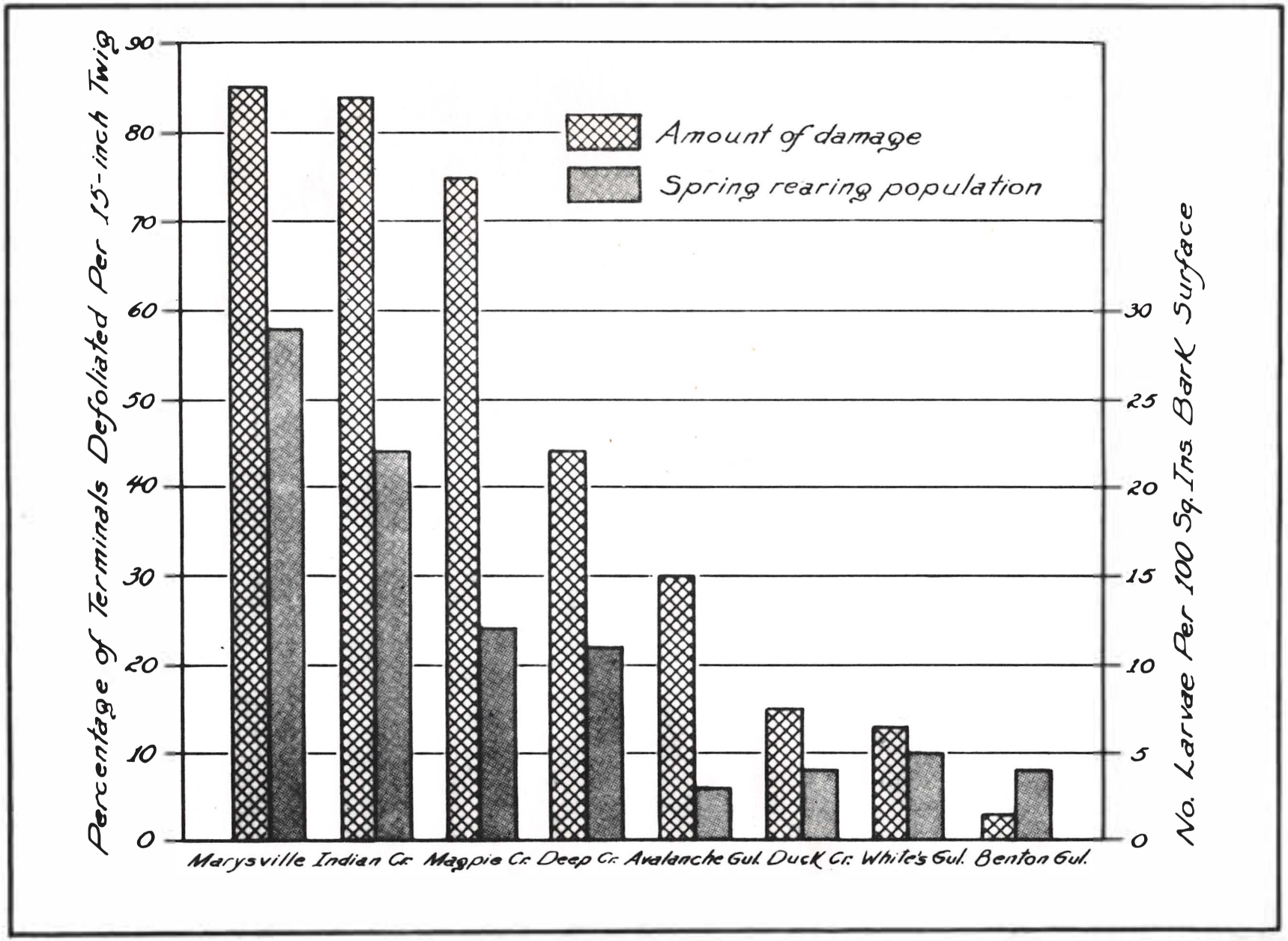


Fig. 3. – Comparison of the number of larvae per 100 sq. inches of bark surface and subsequent defoliation.

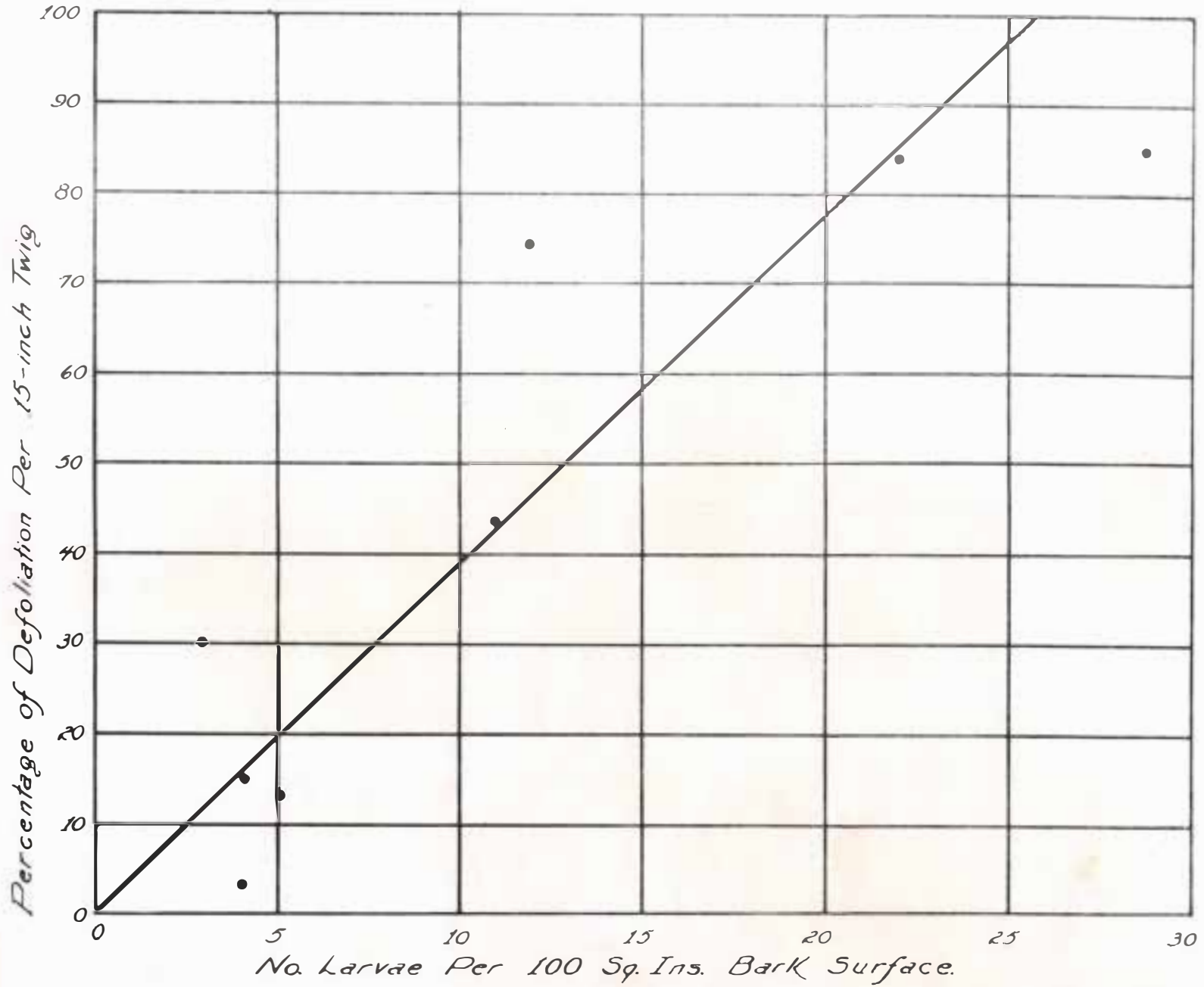


Fig. 4 — Correlation between the number of larvae per unit sample of area and subsequent damage per unit sample of foliage.

criticism could be directed at this graph; nevertheless, considering the small number of samples that served as a basis for the spring emergence figures these results are rather surprisingly indicative.

DISCUSSION

Population Densities As Determined By Forced Emergence of Hibernacula - Forced emergence of hibernacula on bole samples collected prior to the active feeding season offers a practical method for determining population densities of the spruce budworm in the northern Rocky Mountains. In planning limited control work the desirability of identifying areas harboring the greater populations was pointed out. Moreover, yearly records, accumulated by collecting samples and rearing the hibernacula, would be of material aid in determining fluctuations and trends in an infestation.

Several details concerning sampling methods and rearing techniques remain to be clarified before standardized procedures can be adopted. For instance, the type and location of the sample. Sections from the main stem are more practical to handle in both the field and the laboratory. They also lend themselves well for ease of computations, hence are preferable from the standpoint of rearing hibernacula. On the other hand, branch samples are far less difficult to collect and the tree does not have to be sacrificed. The solutions of these problems will be undertaken during the coming season.

Forced Emergence of Hibernacula As An Index of Subsequent Damage - Present data, although not overly promising, suggest the possibility that a correlation index may be determined between the spring-emerging population and subsequent host tree damage. It is recognized that this procedure ignores, or otherwise attempts to sidestep factors such as parasites, predators, and so on.

The extent to which this correlation will be possible, then, will depend primarily upon the variables of environmental resistance influencing normal budworm development. It is even conceivable that if the population were in a state of equilibrium more or less (not necessarily motionless) a correction factor might be developed to include the effects of certain natural enemies.

From an economic standpoint the foremost problem is the determination of the number of samples that will be necessary in given areas. Variations in defoliator populations are greatest between individual trees, and the number of samples necessary to produce reliable data may exceed the ability of limited personnel in regard to the time required for their collection and rearing. In all probability difficulties of this nature can be surmounted by concentrating the work in a fewer number of drainages.

It is hoped that a good insight will be gained into these and other problems during the season of 1951.

References

1. Johnson, Philip C. 1951. Proposed 1951 research program Coeur d'Alene Laboratory. Rept. of the For. Ins. Lab., Coeur d'Alene, Idaho.

2. _____ 1948. Forest insect conditions, Helena National Forest, Montana - Season of 1948. Report of the For. Ins. Lab., Coeur d'Alene, Idaho.

3. _____ 1949. Spruce budworm detection survey Helena, Gallatin, and Deerlodge National Forests, Montana. Report of the For. Ins. Lab., Coeur d'Alene, Idaho.

4. Carolin, V. M. 1950. Studies of the biological control of the spruce budworm in Oregon - 1950. Report of the For. Ins. Lab., New Haven, Conn.